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Aquatic Waste Removal by Robot for Smart City Environment

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ABSTRACT

Water sources are contaminated by garbage, weeds and plastic wastes. Effective waste removal in the water sources such as lakes, ponds and rivers is essential for waste management and control. In Indian setting, Aquatic waste management and control is of main concern for implementing smart city and achieving clean India mission. Therefore the proposed work, aims at developing intelligent solution towards automating the waste removal in lakes. Lake cleaning robot system for removing the surface wastes is experimented in this work. This lake cleaning system uses conveyor along with proximity sensors for detection and DC motors for movement. Arduino UNO controller controls the movement of the robot along with gripper, motors, ultrasonic sensor and IR sensor. The working prototype model of the proposed system exhibits good accuracy with reduced computational time. Henceforth, the developed lake cleaning robot could be used towards reducing water pollution through efficient waste removal for implementing smart city environment.

INTRODUCTION

Water is an important natural resource vital for all forms of life in this planet. Despite of having blessed with enormous amount of water, water pollution is a major crisis in many countries. As per “Water aid”, an organization striving towards attaining fulfillment in hygiene and water sanitation has reported that 80% of the India’s water sources are polluted. Water bodies are being polluted by floating garbage, weeds, debris plastic, sewage, effluents, toxic materials from industries. Water pollution with floating garbage is a serious issue needs immediate attention in developing countries. In Indian context, the union government is keen on projects such as “Swachh Bharat” and “Smart city” for achieving Clean and Smart India mission. Further projects like “Namami Gange”, “Narmada Bachao” focus towards rejuvenation of rivers through effective pollution control and management. River surface cleaning, to remove the solid floating waste is one of the prime objective of the above projects. Indian government has invested enormous amount towards river cleaning project. As per the statistics of Central Pollution Control Board (CPCB), there has been a significant rise in water pollution in water bodies over the past few years. Manual cleaning of water bodies is inefficient, time consuming, laborious and expensive.

In addition, health and hygiene of the laborers doing manual cleaning becomes severely affected. Health impacts also include musculoskeletal, intestinal and vector borne diseases in addition to injuries caused as a result of work related accidents. This demands techniques, to automate the existing infrastructure for river surface cleaning, at low cost with minimal hardware used by layman and general public. Hence to overcome this major problem of waste collection Lake Cleaning Robot is developed. This project aims to provide automatic control to collect the garbage. This lake cleaning system uses Ardiuno UNO Controller along with proximity sensors for detection and DC motors for movement. When the sensor detects static obstacle, the rotating blades start and the garbage is pushed into a bin which is placed right behind the mechanism. The performance of the baseline prototype model of the proposed system tested in a real time emulated environment, justifies the use of lake cleaning robot towards control and management of aquatic waste. Clean water is a basic need for all living beings.

Without water survival in the Earth is not possible. Water covers about 70% of the Earth‟s surface among that only 3% of that is pure water. Water gets polluted due to any reasons like industry waste, sewage waste, garbage waste. Hence it is important to maintain cleanliness and hygiene of water. We considered this water pollution as a serious issue and start to work on the project. We decided to incorporate technology to get the work done effectively and efficiently. Traditional method for collecting water surface floating waste is manual basis, by means of boat trash skimmer. The above methods are costly risky and large time consuming. To eliminate the drawbacks of the above-mentioned methods the remote-controlled water cleaning machine was designed which helps in cleaning the water surface efficiently and eco/friendly. The water waste cleaning Robot consists of Node MCU, DC motor battery pH sensor, Turbidity sensor, Ultrasonic sensor are attached to it for collecting the waste and monitoring the water.

Relevance:

Dumping garbage into rivers and lakes has become common due to a lack of disposal facilities, harming both wildlife and the environment. Animals often mistake plastic waste for food, leading to serious health issues or death. In rapidly growing urban areas, lakes struggle with pollution from litter and runoff, making it hard to keep them clean. Traditional cleaning methods are often inefficient and can harm the ecosystem, and they don't work well with smart city technologies that focus on automation and reducing environme ntal impact. There's a need for better, smarter solutions to tackle this problem effectively. To tackle the challenges of aquatic waste removal in smart cities, we need an innovative approach that fits within the smart city framework. Developing an autonomous lake cleaning robot could offer an effective solution. First, it would automate waste collection, reducing the need for manual labor and enhancing efficiency. Second, the robot could integrate with smart city systems, providing real-time monitoring and data on waste levels and water quality. Lastly, it's crucial that the cleaning process minimizes environmental disruption, ensuring that the aquatic ecosystem remains healthy and balanced while effectively removing waste. This holistic approach addresses both the practical and ecological aspects of water management in urban areas. The project focuses on important environmental issues by developing a robotic system for cleaning up waste in water bodies. Cleaner water leads to healthier ecosystems, better water quality, and protection for wildlife, helping to preserve natural habitats and support biodiversity. By removing waste, the project also improves public health by reducing the risks of diseases linked to contaminated water, making urban areas safer. As cities expand, finding sustainable ways to manage waste and keep water clean is crucial. This project fits into the goals of smart cities by using technology for better waste management, which enhances urban living. Additionally, creating this aquatic waste removal robot represents a significant step forward in robotics and waste management technology, paving the way for more research and innovations in this area.

LITERATURE SURVEY

In this paper discuss strategies to combat the pollution of India's rivers, emphasizing community involvement and innovative cleaning methods. The article highlights successful case studies and government initiatives aimed at river rejuvenation. [1]

In this paper focuses on the challenges faced in cleaning the Cauvery River, detailing both ecological impacts and community efforts. The piece advocates for sustained engagement and policy support to restore river health. [2]

In this paper argues that reducing waste is crucial for effective river cleaning in India. The article emphasizes the importance of public awareness and proactive measures to prevent pollution at its source. [3]

In this paper present a framework for developing intelligent systems aimed at enhancing child safety and security. Their research showcases the potential of integrating technology to create safer environments, which could be adapted for environmental monitoring. [4]

In this paper introduce the concept of a smart e-dustbin designed for urban areas. Their work highlights the integration of technology in waste management systems, demonstrating efficiency and effectiveness in keeping cities clean. [5]

In this paper describe the AGATOR robot model for automatic garbage collection. Their study provides insights into robotic solutions for waste management, emphasizing automation's role in enhancing collection efficiency in aquatic environments. [6]

In this paper discuss an automatic garbage separation robot utilizing image processing techniques. Their research illustrates how technology can streamline waste sorting processes, contributing to better recycling practices. [7]

In this paper present a remote-controlled sewage cleaning machine, detailing its design and functionality. Their work underlines the importance of innovation in addressing sewage management challenges in urban settings. [8]

this paper explore an aquatic multi-robot system for lake cleaning, showcasing its capabilities in maintaining water quality. Their research emphasizes the collaborative potential of robotic systems in environmental management. [9]

In this paper focus on the design and fabrication of a river cleaning system. Their findings highlight engineering solutions that can effectively address river pollution and promote sustainable practices. [10]

In this paper discusses a drainage system cleaner as a solution to environmental hazards. The article emphasizes the necessity of effective drainage management in mitigating pollution and enhancing urban resilience. [11]

In this paper present a pedal-operated boat designed for efficient lake garbage collection. Their research emphasizes user-friendly designs that can promote community involvement in maintaining clean aquatic environments. [12]

METHODOLOGY

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The robot is controlled using a remote that sends commands to an RF transmitter, which passes them to the Arduino UNO. The Arduino then adjusts how the servo motors, DC motors, and conveyor system work based on these commands. The DC motors help the robot move through water, while the servo motors steer it, and a buck converter makes sure everything gets steady power. For collecting waste, the robot has a conveyor system that picks up trash and puts it in a bin onboard. A battery powers all the parts, with the buck converter protecting them from damage by keeping the voltage stable.

Block Diagram:

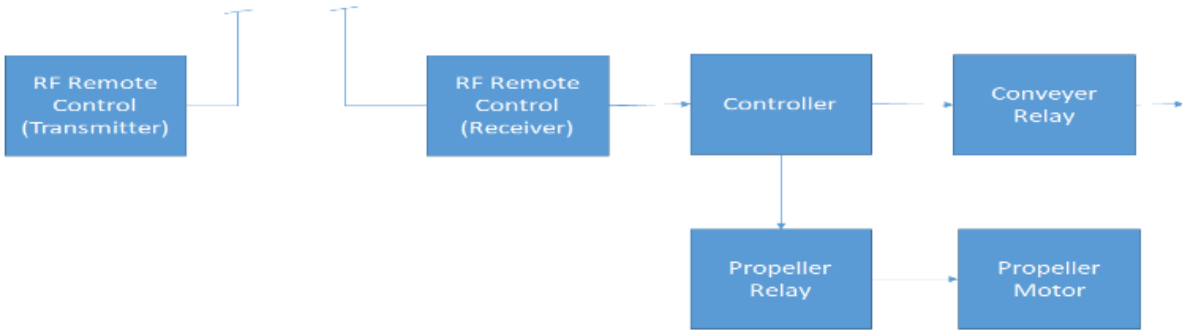

Fig. 1. Block Diagram of Aquatic Waste Removal by Robot for Smart City Environment

The above figure shows block diagram of proposed system. The aquatic waste removing robot consists of a RF transmitter – receiver forming a communication means between the boat and operator. The boat is propelled through battery power motors. The propeller motor is operated through RF remote control and thereby the boat can be moved through the water. The boat is added with a conveyer for collecting the floating wastes on water surface. The controller is programmed to decode the RF signals and control the propelling and waste collection operations. The selection of components is discussed subsequently in this section. This robot uses a combination of remote control, motors, and conveyors to collect aquatic waste and keep the water clean in a smart city.

RF Remote Control (Transmitter and Receiver): The operator uses an RF remote transmitter to send commands wirelessly to the robot's receiver.

Controller: The received signals are processed by the controller, which acts as the brain of the system, deciding how to control the robot's motors and relays.

Conveyor Mechanism: The controller activates a conveyor relay, which powers the conveyor motor. This conveyor helps in collecting waste from the water surface.

Propeller Mechanism: The controller also activates a propeller relay to drive the propeller motor. This propeller allows the robot to move in the water.

Proteus Simulation:

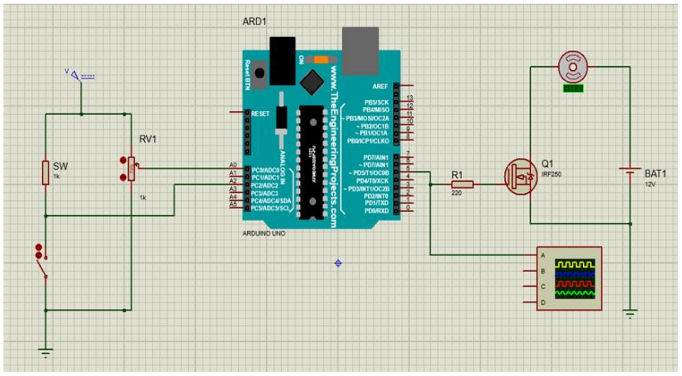

Fig. 2 Simulation

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Results:

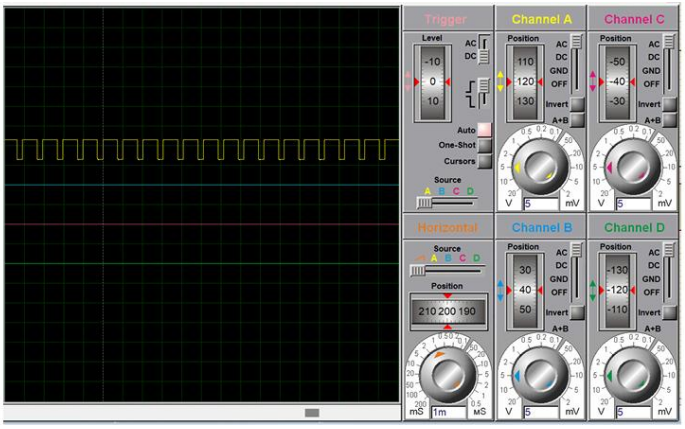


Fig 3 Result

This circuit simulation appears to involve an Arduino Uno microcontroller and additional components to control a high-power device (likely a motor or a load) via a MOSFET. Below is an explanation of the components and their function: The circuit demonstrates an efficient method to control a high-power load, such as a motor, using an Arduino Uno microcontroller in combination with a MOSFET, a potentiometer, a switch, and a 12V power source.

At the heart of the system is the Arduino Uno, which acts as the central control unit. The microcontroller is programmed to interpret input signals from the potentiometer and the switch, generate precise Pulse Width Modulation (PWM) signals, and regulate the operation of the MOSFET. The Arduino's analog pins (A0 to A5) are configured to process the input from the potentiometer, which provides variable resistance. This resistance translates into a corresponding voltage that the Arduino reads as an analog signal. This input determines the duty cycle of the PWM signal, enabling dynamic control of the motor's speed.

The MOSFET, specifically an IRF250, plays a critical role as an electronic switch. Its gate is connected to the Arduino through a 220-ohm resistor, which serves to limit the current flowing into the gate, thereby protecting the circuit and ensuring stable operation. The MOSFET's source-drain pathway is connected to the load and the 12V battery, forming the primary power delivery channel.

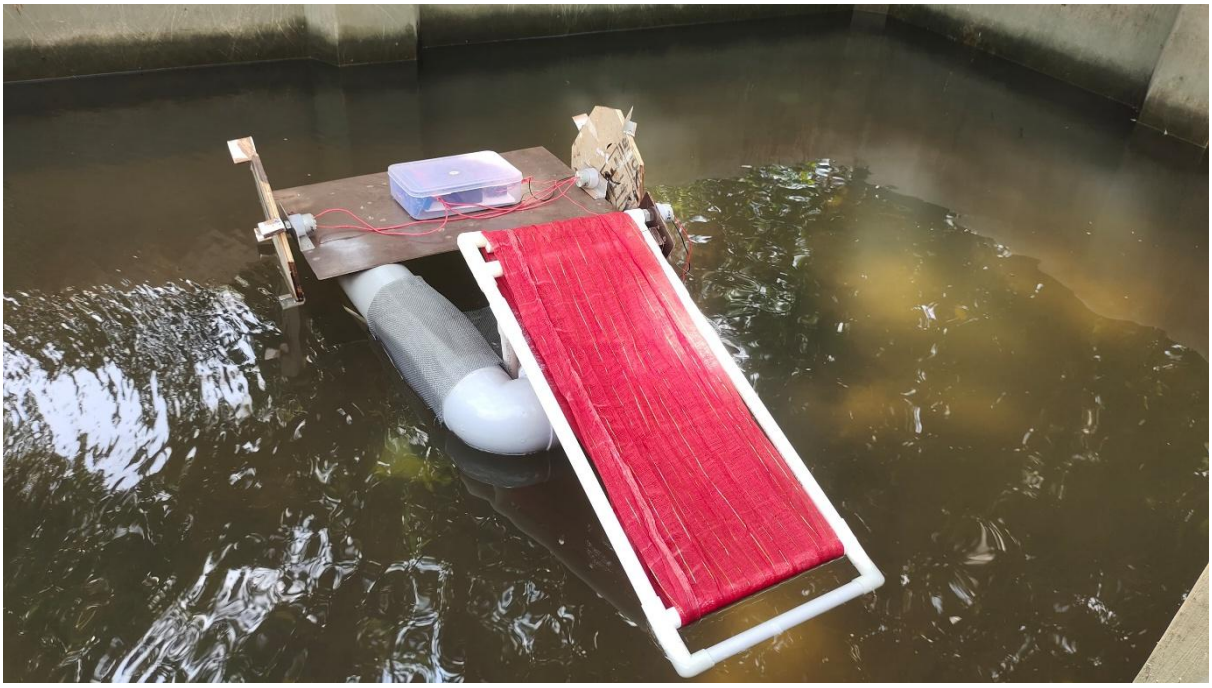
When the Arduino sends PWM signals to the MOSFET gate, the MOSFET modulates the current flow based on the duty cycle of the PWM. A higher duty cycle results in a greater average current flow, increasing the motor's speed, while a lower duty cycle reduces the motor's speed accordingly. The 12V battery serves as the primary power source, delivering sufficient voltage and current to drive the motor or any other connected high-power load. The potentiometer enables manual adjustment of the motor's speed, acting as a user interface for fine-tuning. By varying its resistance, the user changes the voltage signal sent to the Arduino, which subsequently adjusts the PWM duty cycle output. The switch is another input to the Arduino and is likely used to toggle the operation of the load.

When the switch is activated, the Arduino executes its program to enable the MOSFET, allowing current to flow to the motor. This adds an additional layer of control, making the system more interactive and versatile. The Arduino's ability to process multiple inputs and control outputs ensures smooth operation of the entire setup. To visualize and monitor the operation, an oscilloscope or signal analysis block is included in the circuit. This tool captures and displays the PWM signals generated by the Arduino.

These signals are crucial for regulating the motor's speed and can be observed in real-time to ensure proper functioning. The waveforms on the oscilloscope provide insights into the duty cycle and frequency of the PWM signals, enabling debugging and performance optimization. In operation, when the switch is pressed, the Arduino activates the MOSFET, permitting current flow from the battery to the load. The motor starts running, and its speed can be adjusted by turning the potentiometer.

The Arduino dynamically modifies the PWM duty cycle, altering the average power delivered to the motor. This precise control mechanism allows for efficient energy use while maintaining desired performance levels. Overall, the circuit showcases an effective method to manage high-power loads using simple yet robust electronic components, integrating user input, microcontroller logic, and power electronics seamlessly.

Hardware:



CONCLUSION

The Aquatic Waste Removal Robot for Smart City Environment is an innovative solution to the pressing problem of water pollution. By leveraging modern technologies such as Arduino, sensors, and motorized systems, the robot efficiently collects floating garbage and monitors water quality. This reduces dependency on manual, labor-intensive cleaning processes and offers a more sustainable and effective approach to maintaining water cleanliness. The project's significance extends beyond simply removing waste; it also contributes to creating a healthier environment for aquatic ecosystems and communities dependent on these water sources. By promoting cleaner water bodies, this technology supports biodiversity, enhances public health, and aligns with global environmental sustainability goals. Moreover, the project demonstrates the potential for automation and robotics in tackling environmental challenges. With further investment, research, and optimization, the system can be scaled to handle larger areas and integrated with smart city infrastructure for real-time monitoring and waste management. This robot represents a forward-thinking step toward cleaner, healthier water resources, showcasing how technology can drive impactful environmental change. It encourages collaborative efforts from governments, organizations, and individuals to ensure a cleaner and more sustainable future for all.

REFERENCES

[1]. Vikas Dimble and Priyank Hirani "What Can We Do to Clean India‟ Polluted Rivers?", News 18, Web, November 2019.
[2]. Ramakrishnan T, "Cleaning up the Cauvery", The Hindu, Web, June 2019.
[3]. Kum Kum Dasgupta, "To clean rivers, Indian must learn to reduce waste", Hindustan times, Web, November 2019.
[4]. Kumar, S. Arun, and A. Kumaresan, "Towards building intelligent systems to enhance the child safety and security," in 2017 International Conference on Intelligent Computing and Control (I2C2). IEEE, 2017.
[5]. Kolhatkar, C., Joshi, B., Choudhari, P., Bhuva, D, " Smart E-dustbin," in 2018 International Conference on Smart City and Emerging Technology (ICSCET), pp. 1 3, IEEE, 2018.
[6]. Nurlansa, Osiany, Dewi Anisa Istiqomah, and Mahendra Astu Sangha Pavitra, "AGATOR (automatic garbage collector) as automatic garbage collector robot model," in International Journal of Future Computer and Communication, Vol 3(5), pp.367, 2014 .
[7]. Kannan, S. G., S. Sasi Kumar, R. Ragavan, and M. Balakrishnan "Automatic garbage separation robot using image processing technique," in International Journal of Scientific and Research Publications, Vol 6(4), pp.326-328, 2016.
[8]. Idhris, M. Mohamed, M. Elamparthi, C. Manoj Kumar, N. Nithyavathy, K. Suganeswaran, and S. Arunkumar, "Design and fabrication of remote-controlled sewage cleaning Machine", in in International Journal of Engineering Trends and Technology (IJETT), Vol 45(2), March 2017.

[9]. Agrawal, Pranay, and Bishakh Bhattacharya, "Aquatic Multi-Robot System for Lake Cleaning," in Nature-Inspired Mobile Robotics, pp. 171-178. 2013.
[10]. Ballade, Abhijeet M., Vishal S. Garde, Akash S. Lahane, and P. V. Boob, "Design fabrication of river cleaning system," in International Journal of Modern trends in Engineering and research (IJMTER) , Vol 4(2), Feb 2017.
[11]. Daniels, Ndubuisi C. „Drainage System Cleaner A Solution to Environmental Hazards. " International Refereed Journal of Engineering and Science (IRJES) 3, no. 3 (2014): 54-60.
[12]. Jogi, N. G., Akash Dambhare, Kundan Golekar, Akshay Giri, and Shub- ham Take, "Efficient Lake Garbage Collector by Using Pedal Operated Boat," in International Journal of Modern trends in Engineering and Research, Vol 2(4), pp.no 2455 2457,2016.